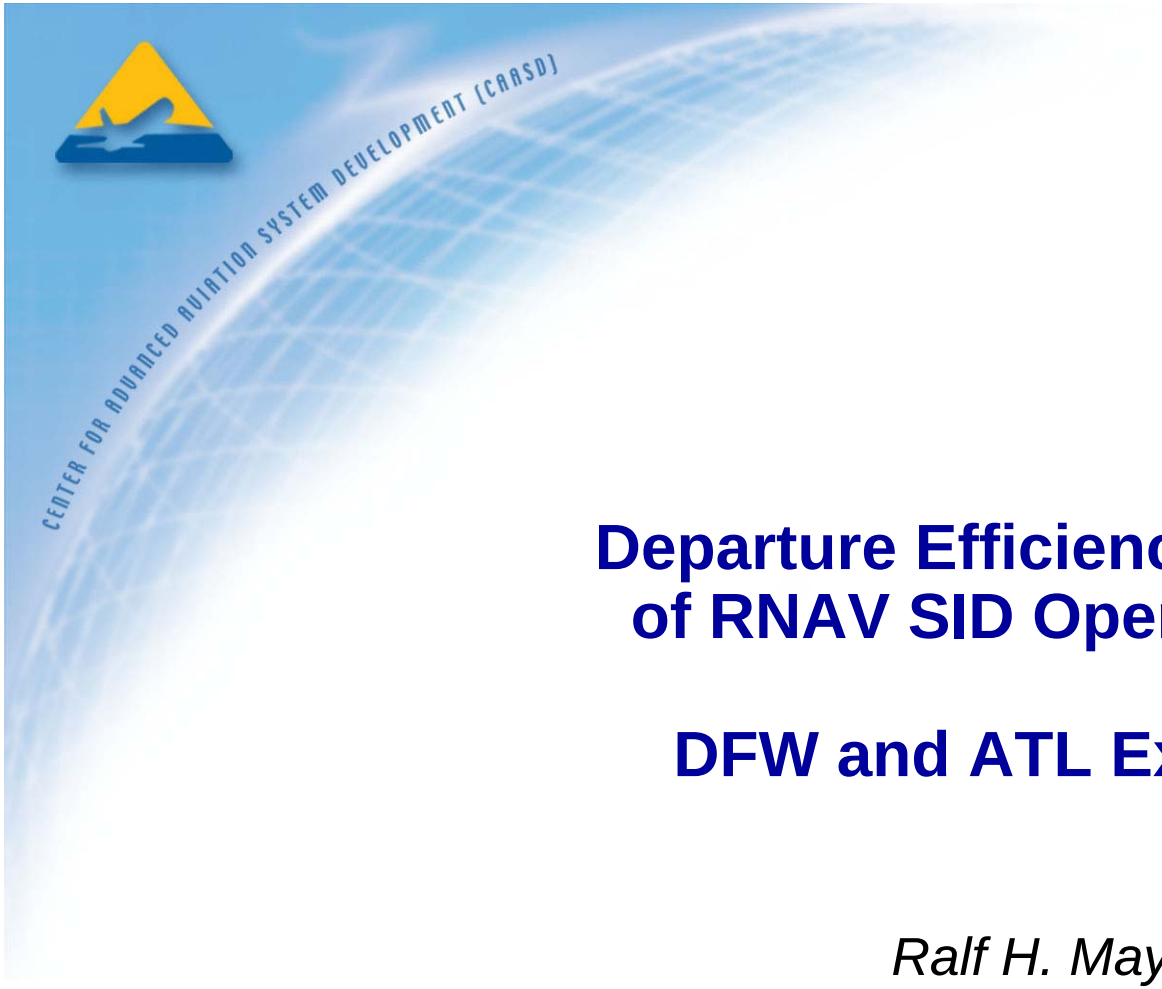


Departure Efficiency Benefits of RNAV SID Operations —

DFW and ATL Examples

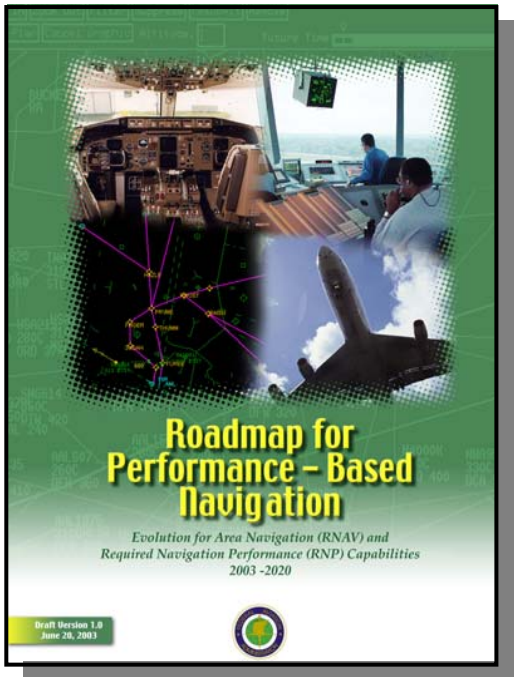
Ralf H. Mayer

ICNS Conference

3 May 2006

Performance-Based Navigation

The Road Map



FAA AC 90-100

U.S. Terminal and En Route Area Navigation (RNAV) Operations
January 2005

The Road Traveled

Airport	Date	Procedure	Status
Las Vegas (America West, Southwest)	Nov 2003	4 STARs and 5 SIDs	Post-implementation analysis
Dulles (United)	Jan 2005	4 STARs	Post-implementation analysis
Philadelphia (US Airways)	March 2005	2 STARs	Post-implementation analysis
Atlanta (Delta)	April 2005	4 STARs 13 SIDs	Post-implementation analysis
Dallas Fort Worth (American)	Sept 2005	16 SIDs	Post-implementation analysis

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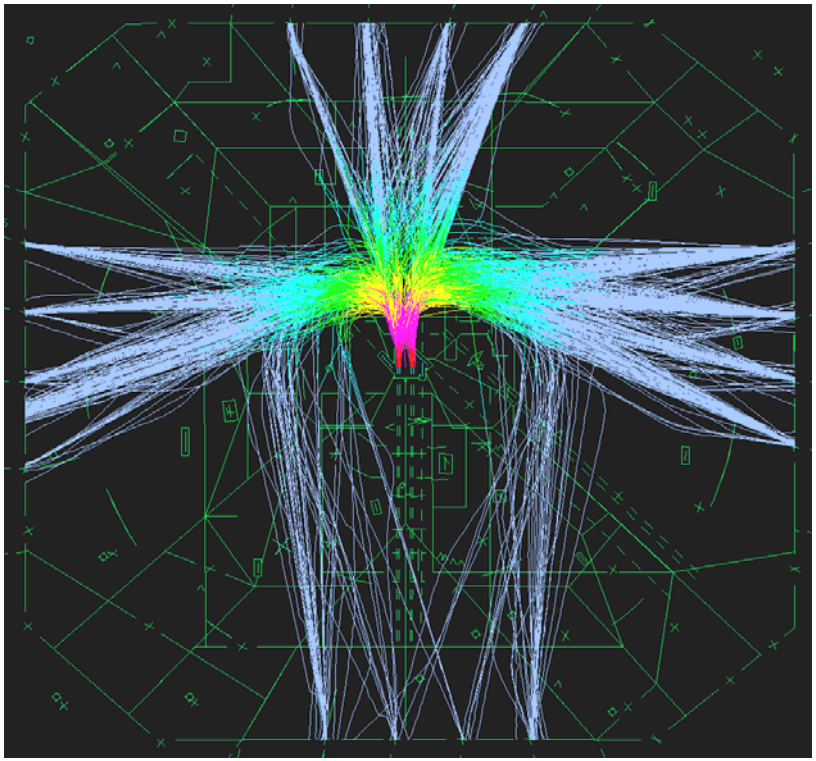
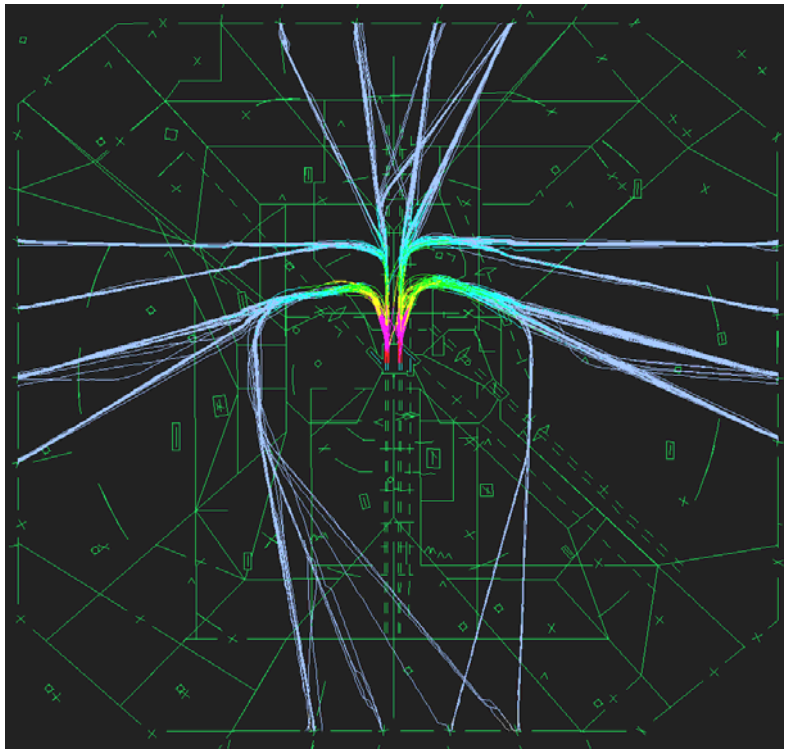
RNAV Departure Operations
DFW Example

Pre RNAV Implementation
Conventional Departures



Post RNAV Implementation
RNAV Departures



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Benefit Metrics

- **Pilot/controller communications benefits**
- **Departure efficiency benefits**
  - Fanned departure operations
    - Airport Capacity
    - Airport Delay
- **Route tracking benefits**
  - Flight Distance
- **Flight performance benefits**
  - Climb Altitude Profile
  - Climb Speed Profile
- **Environmental benefits**
  - Emissions

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Departure Efficiency Metric

- **Departure Efficiency**

$$\text{Departure efficiency} = \frac{\text{Number of departures}}{\text{Unit of time}}$$

- **Improving Departure Efficiency**

$$\text{Improved departure efficiency} = \frac{\text{Increased number of departures}}{\text{Unit of time}}$$

less time between departures
(reduced inter-departure times)

- **Departure Efficiency Metric**
  - **Inter-departure separation time distribution**

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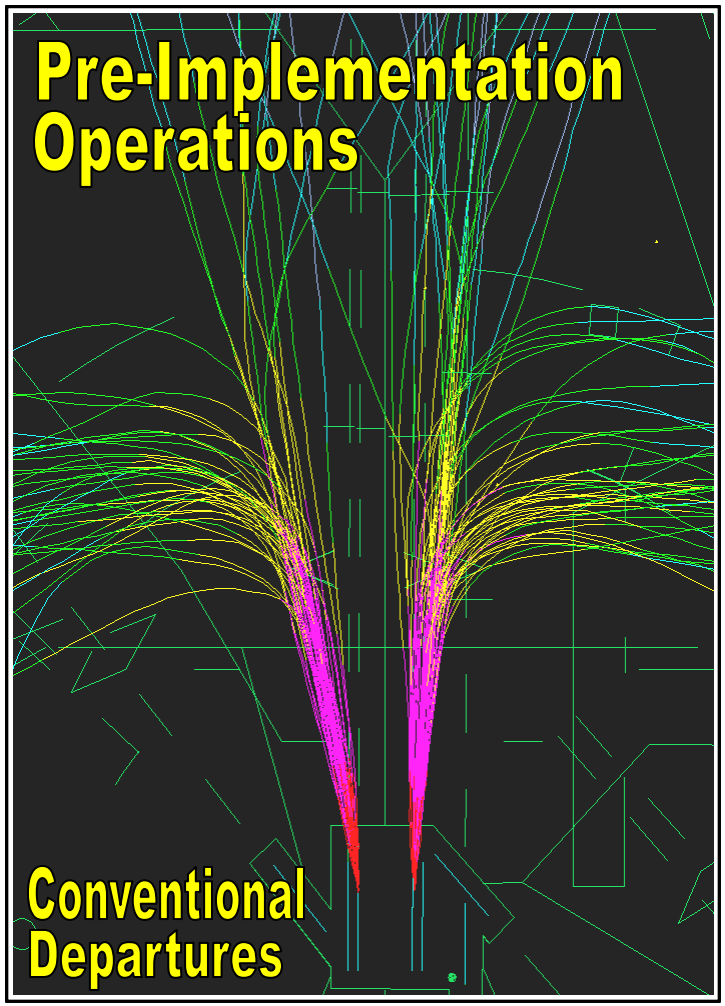
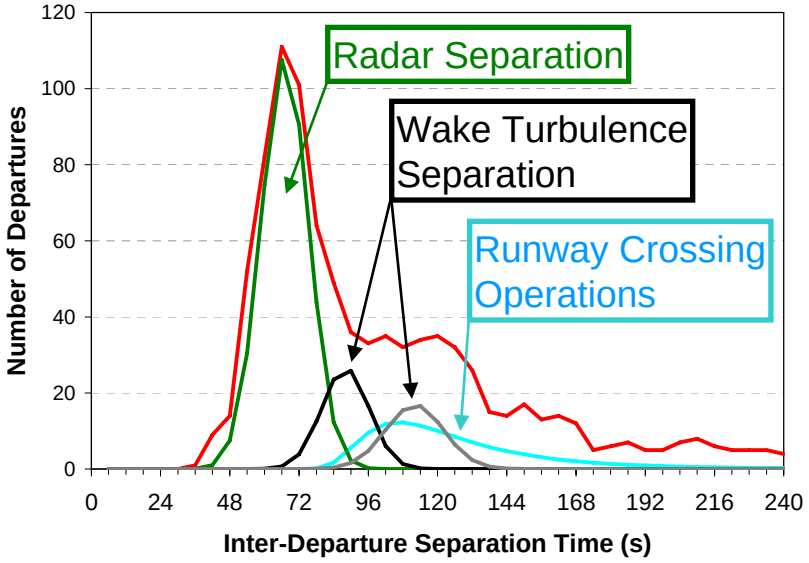
Anatomy of a Departure Efficiency Metric





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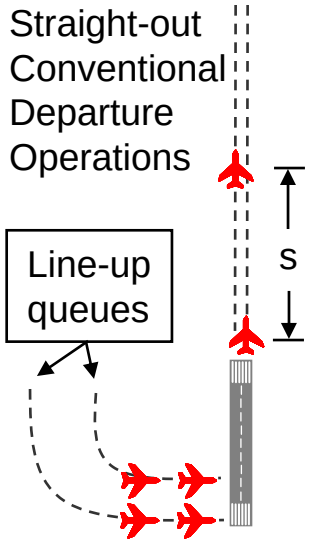
RNAV-enabled Fanned Departure Operations

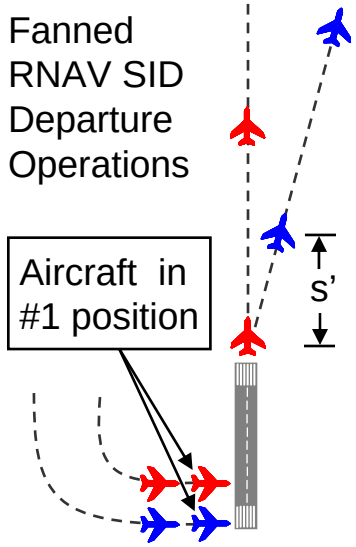
Pre Implementation



Applicable Separation Standards:

- Radar Separation
  (FAAO 7110.65, 5-5-4)
- Wake Turbulence Separation
  (FAAO 7110.65, 5-5-4)

Post Implementation



Applicable Separation Standards:

- Radar Separation
  (FAAO 7110.65, 5-5-4)
- **Same Runway Separation**
  (FAAO 7110.65, 3-9-6)
- Wake Turbulence Separation
  (FAAO 7110.65, 5-5-4)

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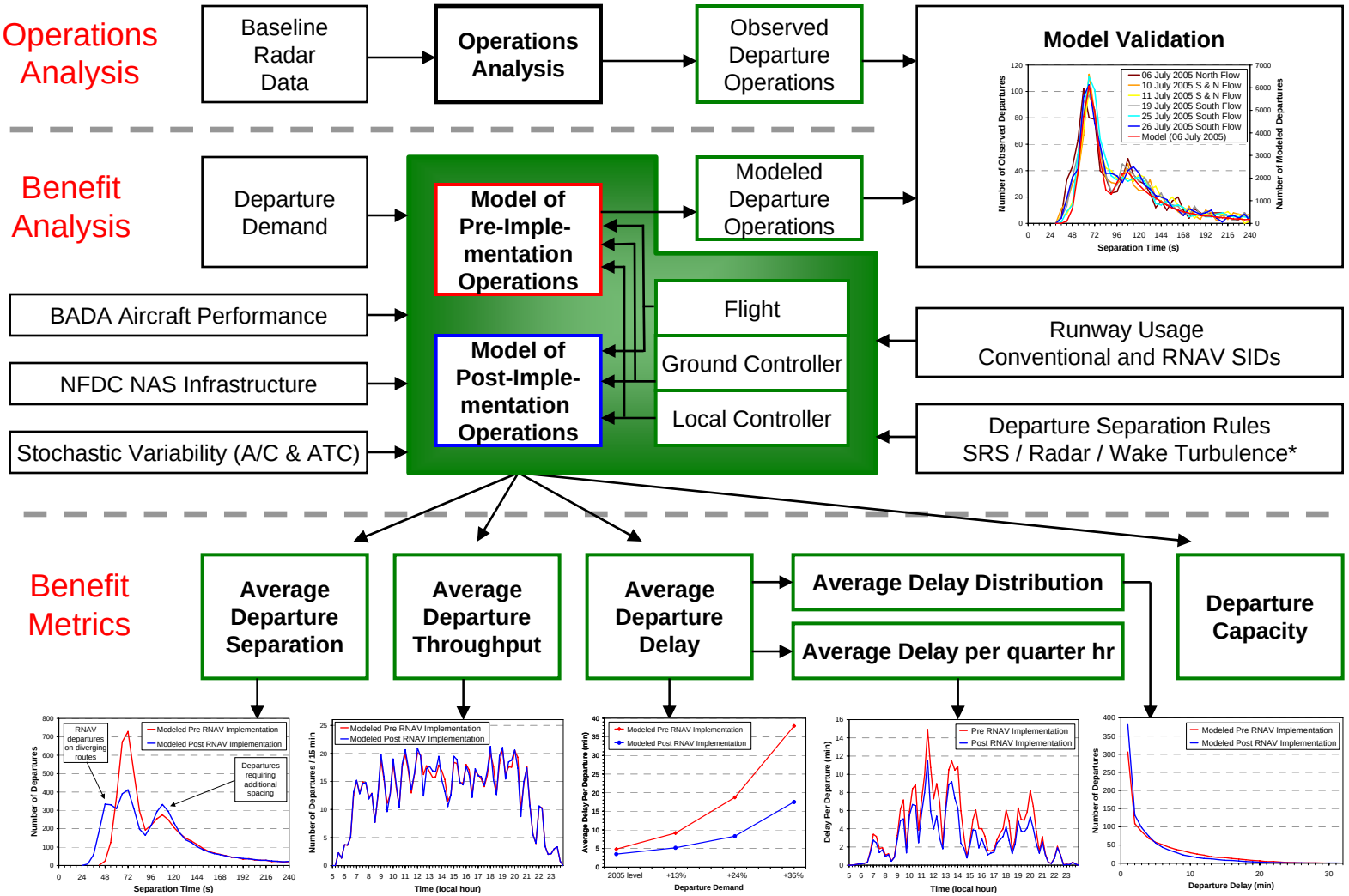
Metric Evaluation Approach



* Additional separation rules as specified by DFW ATCT and TRACON

Key Assumptions

- ETMS-based departure demand subject to stochastic variability
- RNAV participation rates: 84% (current), 92%, and 100%
  - Additional spacing between some RNAV and non-RNAV departures
- ATC sequence optimization rate: 80%
- Traffic increased by 13%, 24%, and 36%
  - Corresponding to 2010, 2015, and 2020 forecasts

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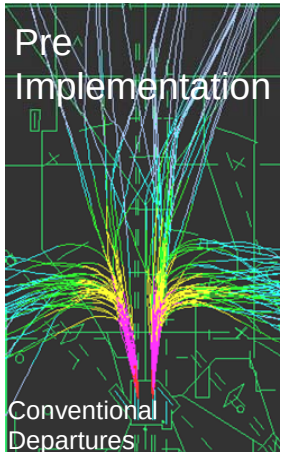
Model Validation



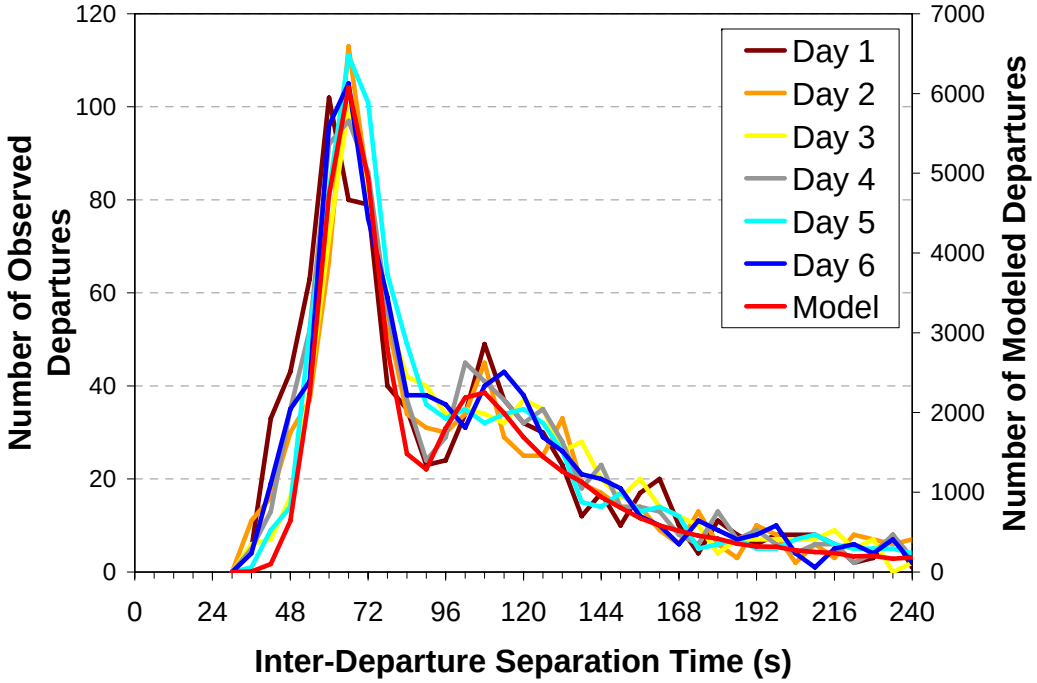
Observed

Straight-out
Conventional
Departure
Operations

Line-up
queues

s

Modeled



Results based on about 1,000 observed operations per day and approximately 50,000 modeled departure operations

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Visualization of Operations

- **Peak Demand Operations**
  - **Example: no arrival-departure dependencies**
  - **Conventional Departures (Baseline)**
    - **Time compression factor: 10**
  - **RNAV Departures (Alternative)**
    - **Time compression factor: 10**
    - **RNAV participation rate: 100%**

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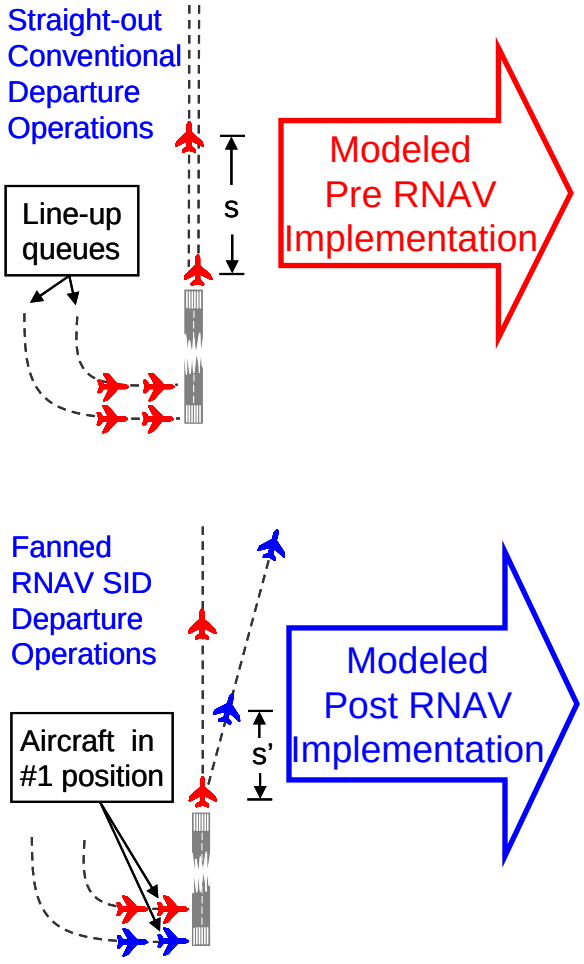
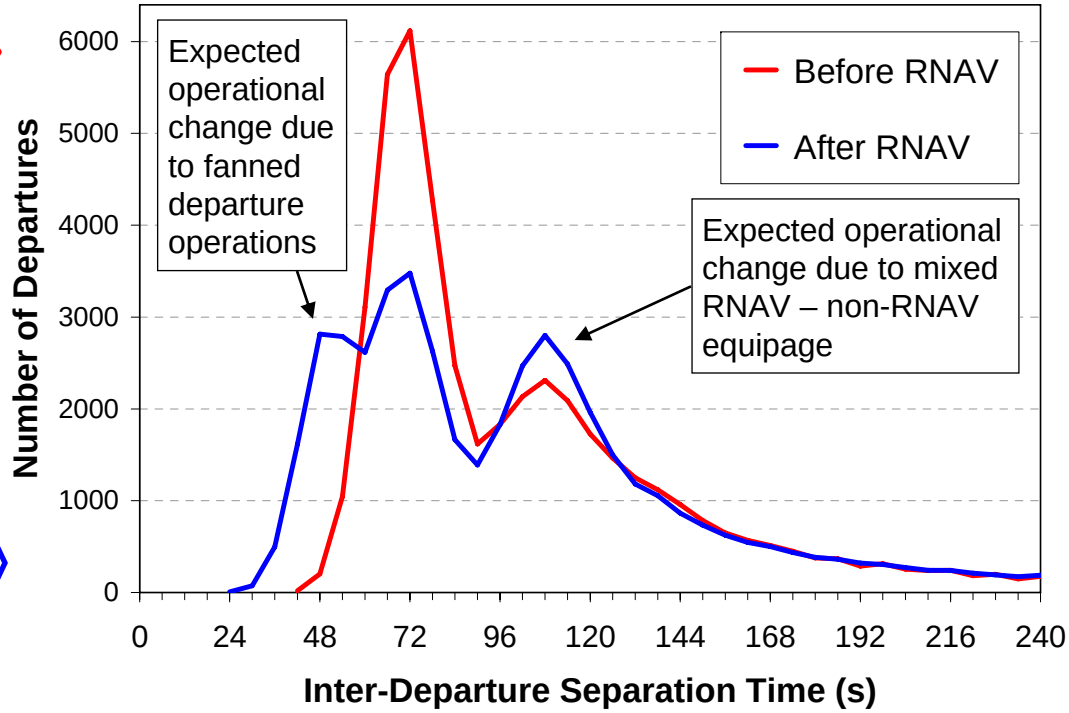
Modeled Departure Efficiency





Results based approximately 50,000 modeled departure operations per modeled scenario

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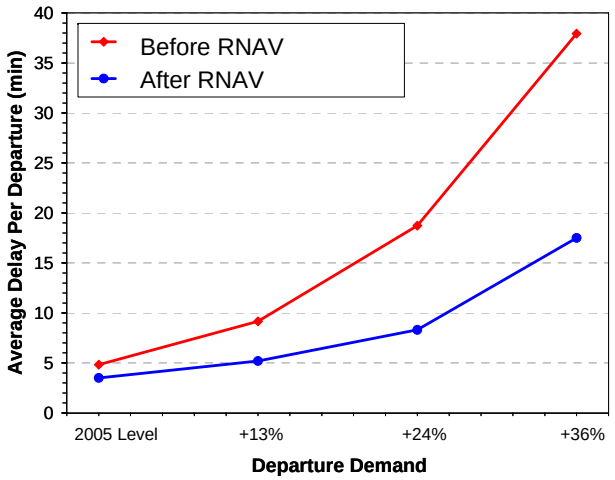
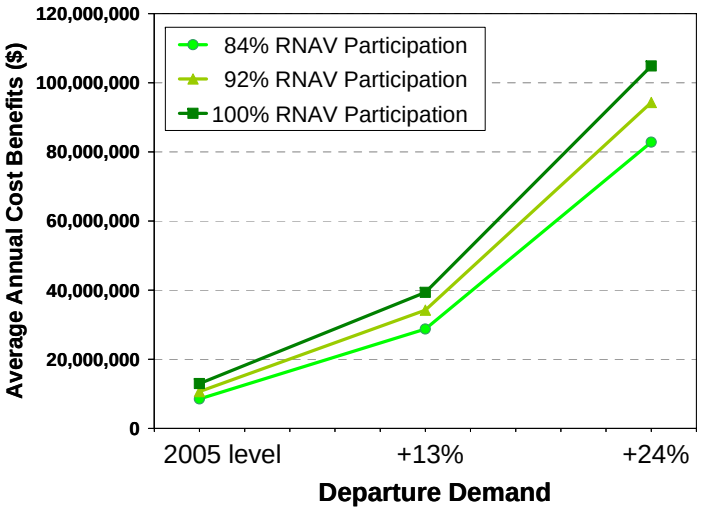
Modeled Departure Efficiency Benefits

- **Airport departure capacity gain**
  - **11 to 20 additional operations per hour (84% to 100% RNAV participation)**
- **Average departure delay reduction per aircraft**
  - **1.3 minutes (Pre – Post Impl.)**
    - 2005 Level of departure demand
- **Annual departure delay reduction benefits to users**
  - **$8.5 million/year**
    - 84% RNAV participation
    - 2005 Level of departure demand





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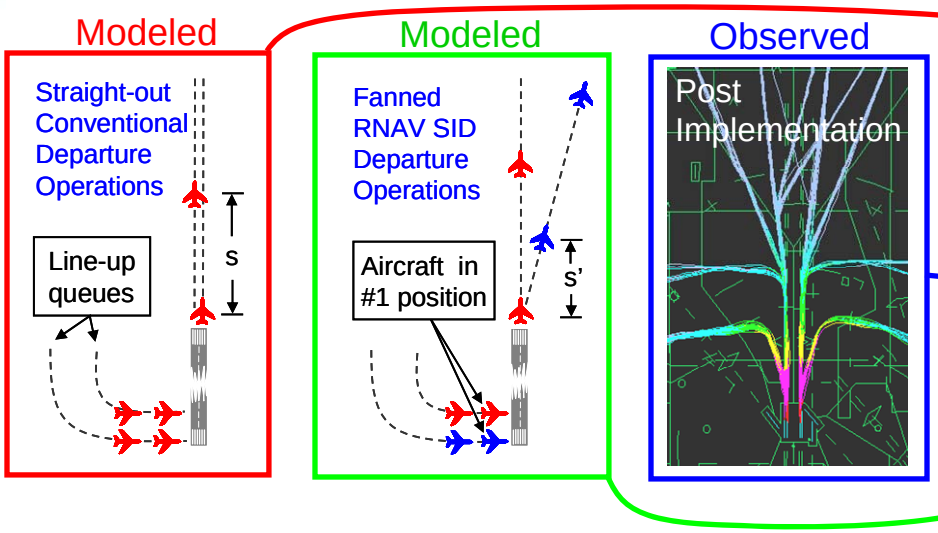
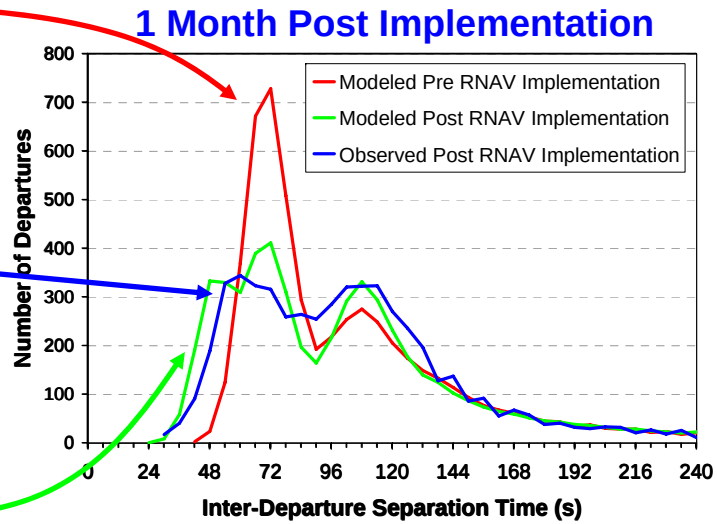
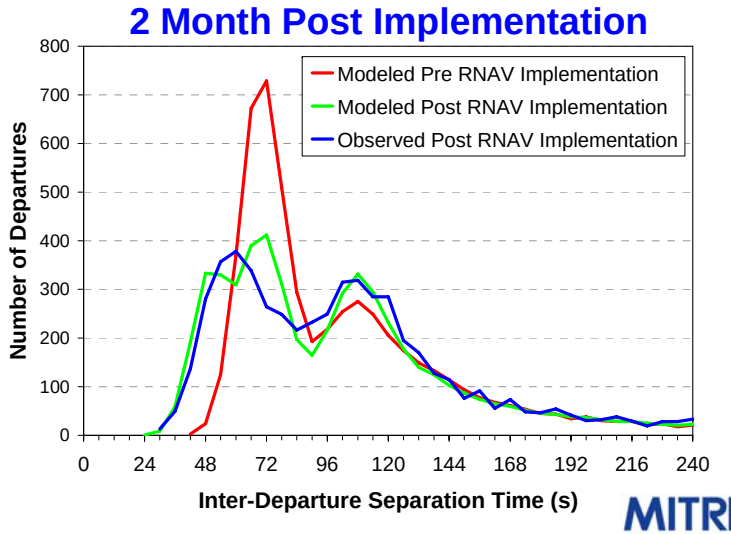
Validation of Departure Efficiency Benefits





- **Validation of Model Estimates**
  - Observed operational changes indicate that departure separation efficiency benefits were largely realized within the first two months after implementation



Summary of DFW and ATL RNAV SID Benefits

- **Separation Efficiency Benefits**
  - **Annual departure delay reduction benefits to users**
    - **DFW** 84% RNAV participation $8.5 M/year
      92% RNAV participation $12 M/year
    - **ATL** 2006 revision (East ops) $11 M/year
      Proposed revision (E & W ops) $28 M/year

- **Next Steps**
  - **Post-implementation evaluation at ATL**
  - **Design optimization**
    - Procedure / airspace design
    - Increased use of route divergence
  - **Procedural separation standards**

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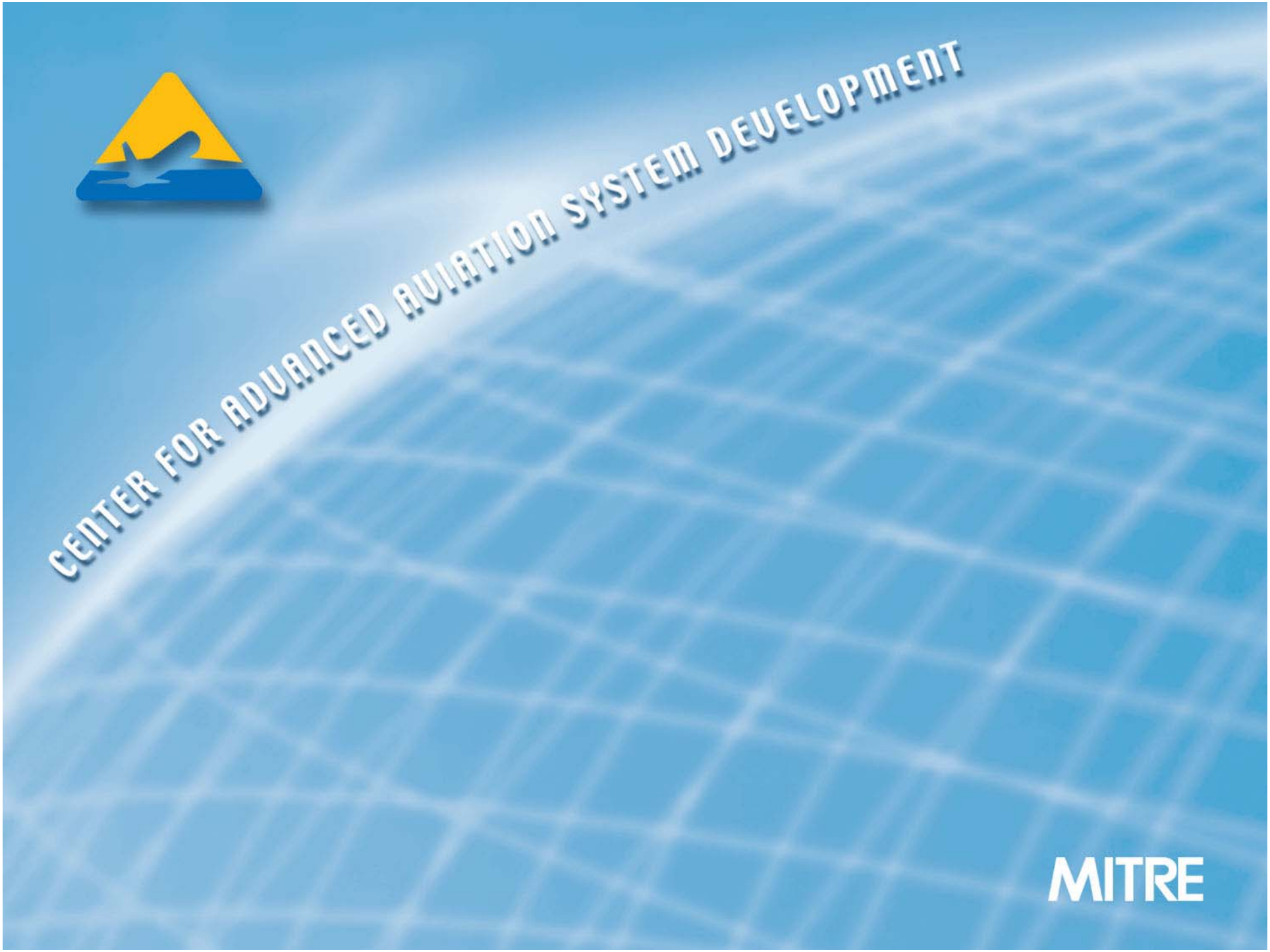
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